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(54) **Method of recording data on card-like recording medium.**

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Description

The present invention relates to a method of recording data on a card-like recording medium, such as an optical card or a magnetic card.

Card-like recording media,such as magnetic or optical cards, are known. Since these record media are portable, the magnetic card is widely used as a credit card or a prepaid card, and the optical card, having larger storage than that of the magnetic card, is expected to be used, for example, as a bank card or a portable map.

An optical card disclosed, for example, in PCT/US82/00187 has a large storage as mentioned above. Therefore, when the data are recorded on a plurality of tracks successively, a recording operation is performed by moving the optical card and a recording head relatively and reciprocally.

In this case, the time required for recording the data is shortened as compared with a one-way recording operation. However, as shown in Figs. 7A and 7B of the accompanying drawings, in which, for example, a data recording operation is performed by moving an optical card 1 reciprocally with respect to a recording head 2, if the data recording operation is performed in both directions, i.e. a normal direction as shown in Fig. 7A and a reverse direction as shown in Fig. 7B, in such a manner that the data are recorded on respective tracks 3 in the same direction using the same modulation method, the data recording direction will vary from track to track. In this case, if a data reading operation is performed in only one direction as usual, the data cannot be read out accurately.

To eliminate the drawback mentioned above, as shown in Fig. 8 of the accompanying drawings, it is possible to read the data by utilizing flags 5 and 6 which are arranged in top and bottom portions of a data block 4 and represent the recording direction of the data block 4. However, in this method, since it is necessary to use regions on the card for recording the flags 5 and 6, the amount of data recordable in respective tracks 3 is decreased. Moreover, since it is necessary to use a circuit for recording the flags 5 and 6 and a circuit for detecting the flags 5 and 6 in a reading operation, the cost of a device for recording and/or reading data on and/or from a card is comparatively high. Further, if the flags 5 and 6 are not detected accurately owing to a defect in the optical card, such as a flaw therein or adhesion of dust thereto, all the data in the data block 4 in which the reading error occurs cannot be read out at all.

In this regard, a method of recording data on a card-like recording medium in which relative reciprocating movement is brought about between said card-like recording medium and a recording head in a first direction and a second direction which is the reverse of the first such that data recordal is carried out in said first and second directions is disclosed in GB-A-2092791. In GB-A-2092791 tracks on the recording medium where recording took place in the reverse direction are "labelled" to indicate this.

According to the present invention there is provided a method of recording data on an optical or magnetic card-like recording medium for subsequent reproduction by means of a reading head, in which method relative reciprocating movement is brought about between said card-like recording medium and a recording head in a first direction and a second direction which is the reverse of the first such that data recordal is carried out in said first and second directions;
characterised by the steps of: recording data to be recorded in said first direction by: modulating such data in accordance with a predetermined modulation method using a first conversion table to produce first modulated data; and writing the said first modulated data in said first direction on said card-like record medium; and recording data to be recorded in said second direction by: reversing the order of such data to produce reversed data; modulating the said reversed data in accordance with the said predetermined modulation method using a second conversion table to produce second modulated data; and writing the said second modulated data in said second direction on said card-like record medium; said first and second conversion tables being formed such that data recorded in the said second direction is reproducible by reading out such data in said first direction and demodulating such read-out data in accordance with said first conversion table, and such that data recorded in the said first direction is reproducible by reading out such data in said second direction and demodulating such read-out data in accordance with said second conversion table.

Thus, in a method embodying the present invention, the card-like record medium is moved reciprocally with respect to the recording head, and the recording operation is performed in both the first and second directions, one of those directions being the "normal" direction and the other direction being the "reverse" direction. In the data recording operation in the normal direction, after parallel data to be recorded are converted into serial data and modulated by a predetermined modulation method, the modulated data are recorded on the card-like record medium. If data are detected as those to be recorded in the reverse direction, however, the parallel data are converted into serial data in such a manner that the recorded data will be in the same order as those recorded in the normal direction if the data are read out in the same direction.

Then, the converted data are modulated in such a manner that the recorded data will be modulated in the same way as those recorded in the normal direction if the data are read out in the same direction, and the converted data are recorded on the card-like record medium.

In this manner, if the data are recorded bi-directionally, i.e. in the normal direction and in the reverse direction, all the data recorded on respective tracks have the same order viewed from one direction regardless of the recording direction. Therefore, it is possible to read the data accurately regardless of the data recording direction.

Reference will now be made, by way of example, to the accompanying drawings, in which:

Fig. 1 is a block diagram of data recording apparatus for effecting a method embodying the present invention;

Figs. 2A and 2B show schematic views for use in explaining a method of modified frequency modulation (MFM);

Figs. 3A to 3C, 4A to 4C and 5 show schematic views for use in explaining operation of the apparatus shown in Fig. 1:

Fig. 6 is a block diagram of a circuit corresponding to the data recording apparatus shown in Fig. 1: and

Figs. 7A, 7B and 8 (described above) show schematic views for use in explaining a known method of recording data.

In Fig. 1, a main part of the data recording apparatus comprises a buffer memory 11 for storing data to be recorded, a parallel/serial converter 12 for converting parallel data supplied from the buffer memory 11 in a predetermined order into serial data, and a modulator 13 for modulating the converted serial data. The modulated data are supplied to a recording head not shown which is moved reciprocally and relatively with respect to an optical card to record the data on the optical card in an optical manner. Moreover, the buffer memory 11, the parallel/serial converter 12 and the modulator 13 are controlled by a recording direction command signal outputted from for example a driving portion for moving the optical card reciprocally or a controlling portion of the driving portion.

Hereinafter, it is assumed that a recording direction shown in Fig. 7A is a normal direction and a recording direction shown in Fig. 7B is a reverse direction, and an operation of the embodiment mentioned above will be explained.

In the recording operation of the normal direction, when the recording direction command signal representing the normal direction is supplied to the buffer memory 11, the buffer memory 11 supplies the data to be recorded in a predetermined order i.e. for example as a parallel data constructed from a top of a data block to the parallel/serial converter 12. In the parallel/serial converter 12, the parallel data are converted successively into serial bit array from for example a most significant bit (MSB), and are supplied to the modulator 13 as a serial data. In the modulator 13, the serial data are modulated by the known various modulation methods such as a frequency modulation method and a modified frequency modulation method, and the modulated data are supplied to a recording head not shown so as to record the data on the optical card.

The recording operation in the normal direction mentioned above is the same as that of the known one for the magnetic disc, the optical disc, etc.

In the recording operation of the reverse direction, when the recording direction command signal representing the reverse direction is supplied to the buffer memory 11, the buffer memory 11 supplies the data to be recorded in the reverse order as that in the normal direction as the parallel data. That is to say, since the data are outputted from the top of the data block in the recording operation of the normal direction, the data are successively outputted from a bottom to the top of the data block in this recording operation of the reverse direction. The parallel data are supplied to the parallel/serial converter 12 and are converted in a reverse manner as that in the normal direction into the serial data. That is to say, since the data are converted from the most significant bit (MSB) in the recording operation of the normal direction, the data are successively converted from the least significant bit (LSB) in the recording operation of the reverse direction into the serial data, and the thus converted serial data are supplied to the modulator 13. In the modulator 13, the serial data are converted successively by the modulation method such that the modulated data have the same order as data recorded in the normal direction when they are read out in the same direction. Then, the modulated data are supplied to the recording head and are recorded on the optical card.

Hereinafter, an embodiment of the present invention, in which modified frequency modulation (MFM) is performed, will be explained.

Modified frequency modulation is used for recording on magnetic and optical discs. As shown in Figs. 2A and 2B, wherein the modulation method of the modified frequency modulation is explained, the data modulated by the MFM method can be obtained in such a manner that a window ab is moved bit by bit as shown in Fig. 2A and two bits corresponding to the data of the window ab are selected from a first conversion table shown in Fig. 2B.

Figs. 3A to 3C. are schematic views for explaining an operation of the MFM in the normal direction. In this embodiment, parallel data are supplied as 12H, 34H in this order, wherein H shows

that the data 12 is a hexadecimal notation. The parallel data 12H are successively converted into serial data from the most significant bit (MSB), and the serial data "00010010" are obtained as shown in Fig. 3B. Then, the serial data are modulated by the MFM method to obtain modulation data shown in Fig. 3C.

Figs. 4A to 4C are schematic views for explaining an operation of the MFM in the reverse direction. In this embodiment, parallel data are supplied as 34H, 12H in the reverse order as that of the normal direction. The parallel data 12H are converted from the least significant bit into the serial data "01001000" as shown in Fig. 4B, and the serial data are modulated in accordance with the second conversion table shown in Fig. 5 to obtain modulation data shown in Fig. 4C. The thus obtained modulation data have the same order as that of the normal direction shown in Fig. 3C if viewed from the right side on the figure.

Fig. 6 shows circuitry incorporating the parallel/serial converter 12 and the modulator 13 shown in Fig. 1. In this embodiment, the parallel/serial converter 12 comprises an 8 bits bi-directional shift register 14 and a half frequency divider 15, and the modulator 13 comprises a process circuit 16 and a 2 bits shift register 17. When a parallel data load signal is supplied to the shift register 14, the parallel data are supplied from the buffer memory 11 (Fig. 1) to the bi-directional shift register 14. In this case, it is assumed that a recording direction command signal DIR shows the normal direction when it is "1" and the reverse direction when it is "0". Moreover,the modulation clock is supplied for effecting the half frequency divider 15 at a trailing edge thereof and for shifting the parallel data previously loaded to the bi-directional shift register 14 by one bit at a leading edge thereof. In this case, the shifting operation is performed in a left direction on Fig. 6 when the DIR is"1" and in a right direction on Fig. 6 when the DIR is "0".

Outputs of the 8 bits bi-directional shift register 14 are supplied to a, b, c, d input terminals of the process circuit 16 respectively and are outputted as Z1 and Z2. When the recording operation is performed in the normal direction, use is made of the data supplied to the c, d input terminals, and when the recording operation is performed in the reverse direction, use is made of the data supplied to the a, b input terminals. In the process circuit 16, the processing operation is performed as follows.

$$Z1 = s\bar{c}\bar{d} + \bar{s}a$$

$$Z2 = sc + \bar{s}\bar{a}\bar{d}$$

Then, the processed data Z1 and Z2 are supplied to the 2 bits shift register 17 when a frequency divide clock is supplied to the shift register 17 from the half frequency divider 15, and are shifted at the leading edge of the modulation clock to obtain the modulation data. That is to say, when the 8 bits bi-directional shift register 14 is shifted by one bit, the 2 bits shift resister 17 is shifted by two bits.

The modulation data thus obtained are the data modulated by the normal MFM method when the recording operation is performed in the normal direction, and are the data modulated in the same manner as that of the normal direction if readout from the same reading direction as that of the normal direction.

In the embodiment mentioned above, the explanation is performed in the case that the modulation method is MFM, but it is possible to use other modulation methods. Moreover, an embodiment of the present invention can be applied not only to recording data on optical cards, as mentioned above, but also on other card-like record mediums such as magnetic cards.

As mentioned above, according to the present invention, since the data recording operation is performed in the manner that the data are recorded in the same order and the same modulation method when viewed from one direction of the relative and reciprocal movement, it is not necessary to use a recording region for a flag used for the detection of the recording direction, and thus the record medium can be utilized more effectively. Moreover, since it is not necessary to use a circuit for recording the flag and a circuit for detecting the flag in a data reading operation, the data reading apparatus can be made inexpensive in cost. Further, since the detection error of the flag does not occur, the data can be read out more accurately, and thus the reliability of the reading operation can be improved.

Claims

1. A method of recording data on an optical or magnetic card-like recording medium (1) for subsequent reproduction by means of a reading head, in which method relative reciprocating movement is brought about between said card-like recording medium (1) and a recording head (2) in a first direction and a second direction which is the reverse of the first such that data recordal is carried out in said first and second directions;

characterised by the steps of:

recording data to be recorded in said first direction by: modulating such data in accordance with a predetermined modulation method using a first conversion table to produce

first modulated data; and writing the said first modulated data in said first direction on said card-like record medium (1); and

recording data to be recorded in said second direction by: reversing the order of such data to produce reversed data; modulating the said reversed data in accordance with the said predetermined modulation method using a second conversion table to produce second modulated data; and writing the said second modulated data in said second direction on said card-like record medium (1);

said first and second conversion tables being formed such that data recorded in the said second direction is reproducible by reading out such data in said first direction and demodulating such read-out data in accordance with said first conversion table, and such that data recorded in the said first direction is reproducible by reading out such data in said second direction and demodulating such read-out data in accordance with said second conversion table.

2. A method as claimed in claim 1, wherein parallel data in a buffer memory (11) are read out in accordance with the data recording direction and are supplied to a parallel/serial converter (12) to obtain serial data in accordance with the data recording direction.

3. A method as claimed in claim 2, wherein said parallel data is processed in the parallel/serial converter one byte at a time.

4. A method as claimed in claim 2 or 3, wherein said modulation is performed from a most significant bit in one of the said first and second directions and from a least significant bit in the other of the said first and second directions.

5. A method as claimed in any preceding claim, wherein said predetermined modulation method is a modified frequency modulation method.

Patentansprüche

1. Verfahren zum Aufzeichnen von Daten auf einem optischen oder magnetischen, kartenähnlichen Aufzeichnungsmedium (1) zur nachfolgenden Wiedergabe durch einen Lesekopf, wobei verfahrensgemäß das kartenähnliche Aufzeichnungsmedium (1) und ein Aufzeichnungskopf (2) gegeneinander in einer ersten Richtung und in einer zweiten Richtung, die zur ersten entgegengesetzt ist, hin und herbewegt werden, so daß die Datenaufzeichnung in der ersten und in der zweiten Richtung erfolgt; gekennzeichnet durch die Schritte: Aufzeichnen der aufzuzeichnenden Daten in der ersten Richtung durch Modulieren solcher Daten nach einem vorbestimmten Modulationsverfahren, wobei eine erste Umsetztafel verwandt wird, und Erzeugen von ersten modulierten Daten; und Schreiben der ersten modulierten Daten in der ersten Richtung auf das kartenähnliche Aufzeichnungsmedium (1); und

Aufzeichnen der aufzuzeichnenden Daten in der zweiten Richtung durch Umkehren der Anordnung von solchen Daten und Erzeugen von umgekehrten Daten; Modulieren der umgekehrten Daten nach einem vorbestimmten Modulationsverfahren, wobei eine zweite Umsetztafel verwandt wird, und Erzeugen von zweiten modulierten Daten; und Schreiben der zweiten modulierten Daten in der zweiten Richtung auf das kartenähnliche Aufzeichnungsmedium (1),

wobei die erste und die zweite Umsetztafel so gestaltet sind, daß in der zweiten Richtung aufgezeichnete Daten durch Lesen solcher Daten in der ersten Richtung und durch Demodulieren der gelesenen Daten mit der ersten Umsetztafel wiedergegeben werden können, und daß in der ersten Richtung aufgezeichnete Daten durch Lesen solcher Daten in der zweiten Richtung und durch Demodulieren der gelesenen Daten mit der zweiten Umsetztafel wiedergegeben werden können.

2. Verfahren nach Anspruch 1, wobei parallele Daten in einem Pufferspeicher (11) gemäß der Datenaufzeichnungsrichtung ausgelesen und an einen Parallel-Seriell-Umsetzer (12) angelegt werden, so daß Daten gemäß der Datenaufzeichnungsrichtung erhalten werden.

3. Verfahren nach Anspruch 2, wobei die parallelen Daten im Parallel-Seriell-Umsetzer byteweise verarbeitet werden.

4. Verfahren nach Anspruch 2 oder 3, wobei die Modulation in der ersten oder der zweiten Richtung, ausgehend vom höchstwertigen Bit, und in der anderen der beiden Richtungen, ausgehend vom niedrigstwertigen Bit, erfolgt.

5. Verfahren nach irgendeinem vorangehenden Anspruch, wobei das vorbestimmte Modulationsverfahren ein modifiziertes Frequenzmodulationsverfahren ist.

Revendications

1. Procédé pour enregistrer des données. sur un support d'enregistrement optique ou magnéti-

que (1) analogue à une carte en vue d'une reproduction ultérieure au moyen d'une tête de lecture. procédé dans lequel un mouvement de va-et-vient relatif est créé entre ledit support d'enregistrement (1) analogue à une carte et une tête d'enregistrement (2) dans une première direction et dans une seconde direction qui est l'inverse de la première direction de telle sorte qu'un enregistrement de données est effectué dans lesdites première et seconde directions;

caractérisé par les étapes consistant :

à enregistrer les données à enregistrer dans ladite première direction en : modulant ces données en fonction d'un procédé de modulation prédéterminé faisant appel à une première table de conversion pour produire des premières données modulées; et à écrire lesdites premières données modulées dans ladite première direction sur ledit support d'enregistrement (1) analogue à une carte; et

à enregistrer les données à enregistrer dans ladite seconde direction en : inversant l'ordre de ces données pour produire des données inversées; en modulant lesdites données inversées en fonction dudit procédé de modulation prédéterminé faisant appel à une seconde table de conversion pour produire des secondes données modulées; et en écrivant lesdites secondes données modulées dans ladite seconde direction sur ledit support d'enregistrement (1) analogue à une carte;

lesdites première et seconde tables de conversion étant formées de telle sorte que les données enregistrées dans ladite seconde direction soient reproductibles par lecture de ces données dans ladite première direction et par démodulation de ces données lues en fonction de ladite première table de conversion. et de telle sorte que les données enregistrées dans ladite première direction soient reproductibles par lecture de ces données dans ladite seconde direction et par démodulation de ces données lues en fonction de ladite seconde table de conversion.

2. Procédé selon la revendication 1, dans lequel on lie des données parallèles dans une mémoire tampon (11) en fonction de la direction d'enregistrement de données et on les envoie à un convertisseur parallèle/série (12) pour obtenir des données série en fonction de la direction d'enregistrement des données.

3. Procédé selon la revendication 2, dans lequel on traite lesdites données parallèles dans un convertisseur parallèle/série octet par octet.

4. Procédé selon la revendication 2 ou 3, dans lequel on effectue ladite modulation à partir du bit le plus significatif dans l'une desdites première et seconde directions et à partir d'au moins le bit le moins significatif dans l'autre desdites première et seconde directions.

5. Procédé selon n'importe quelle revendication précédente, dans lequel ledit procédé de modulation prédéterminé est un procédé de modulation de fréquence modifié.

FIG_1

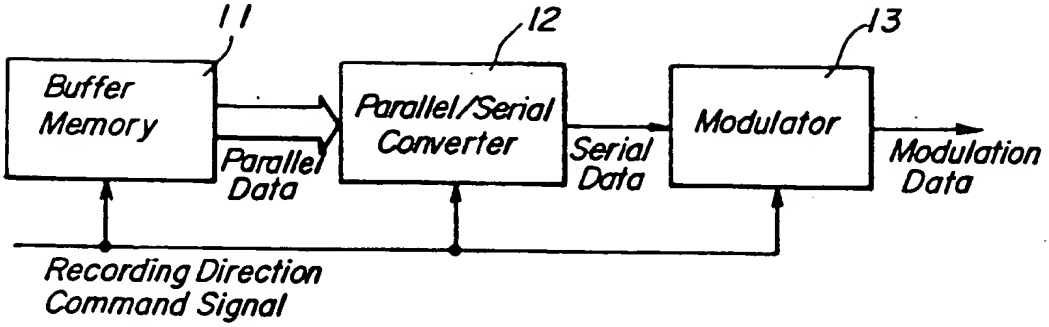
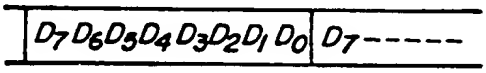


FIG_2A



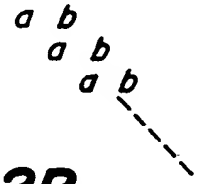


FIG_2B

a	b	MFM Data
0	0	1 0
0	1	0 1
1	0	0 0
1	1	0 1

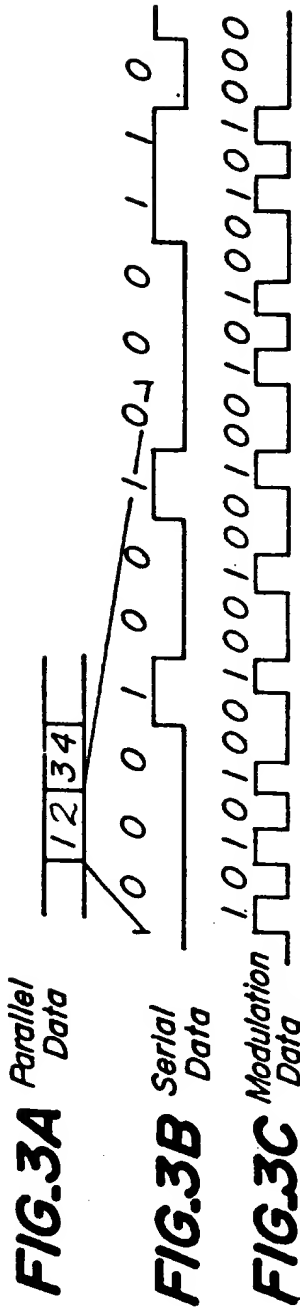


FIG.3A

FIG.3B

FIG.3C

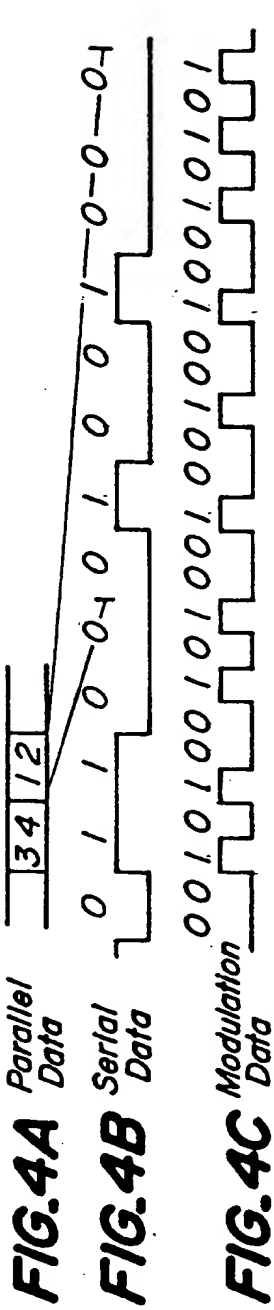


FIG.4A

FIG.4B

FIG.4C

FIG.5

a	b	MFM Data	
0	0	0	1
0	1	0	0
1	0	1	0
1	1	1	0

FIG.6

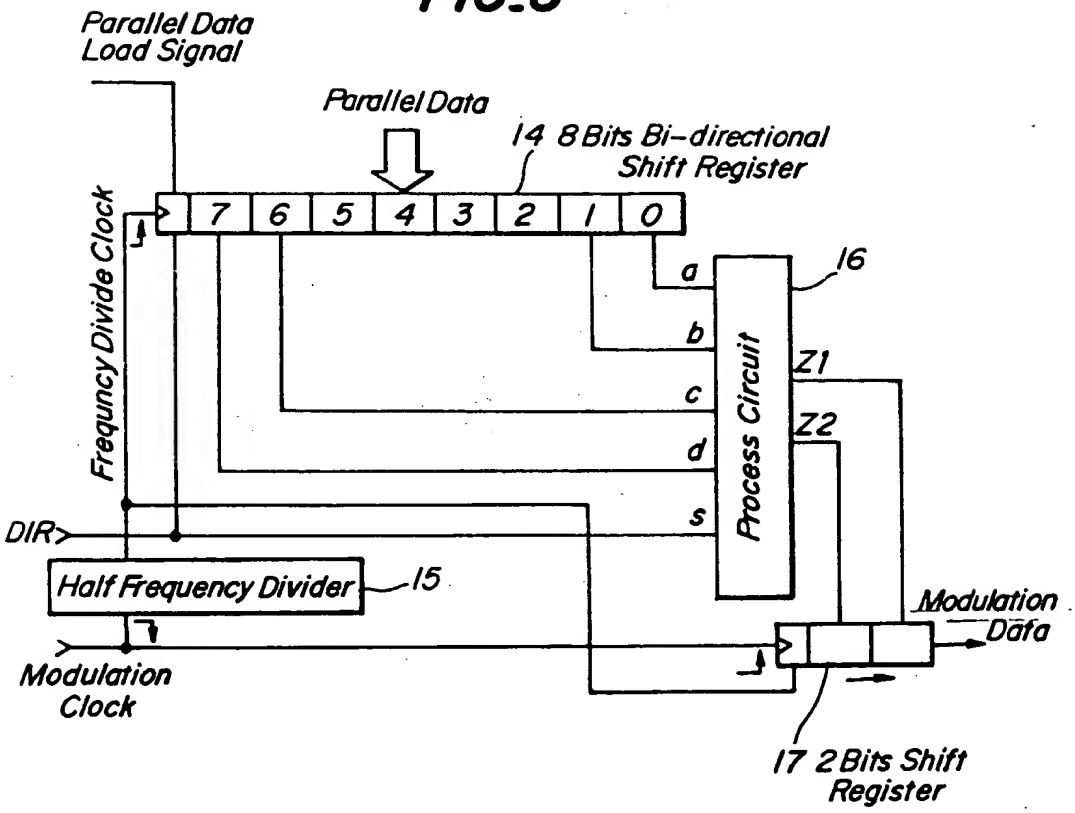


FIG.7A

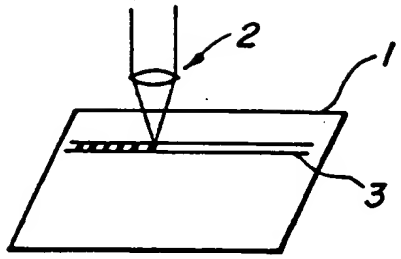


FIG.7B

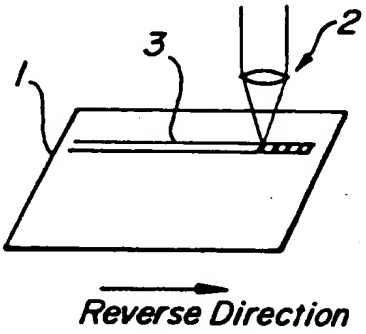


FIG.8